

Wind Generators

At right, hilltop ridges near San Francisco are covered with wind generators, or "windmills," of various designs. This "wind farm" is typical of facilities around the world that utilize wind energy to drive a turbine that generates electricity for use by utility companies. Many of these wind systems employ an advanced generator controller—manufactured by Enerpro Inc., Goleta, California—that incorporates technology originally developed at Marshall Space Flight Center (MSFC) as part of NASA's energy conservation research of the 1970s.

MSFC engineer Frank Nola invented a way of curbing power wastage: a device called the Power Factor Controller (PFC) that matches voltage with an AC motor's actual need rather than its standard fixed voltage, which is needed to handle the heaviest loads the motor is designed to carry. The PFC continuously determines motor load by sensing shifts in the relationship between voltage and current flow; when it senses a light load, it cuts the voltage to the minimum needed, which also reduces current flow and heat loss. With great potential for energy savings over a very broad range of applications, the PFC has become one of the most widely adopted technology transfers.

In 1985, Enerpro president Frank J. Bourbeau (right) conceived a novel means of synchronizing a wind generator to the electric utility grid. In testing the concept on a wind farm machine, he found the generator's controller to be unstable. He devised a way of stabilizing the controller and filed for a patent, but in the course of the patent search he learned of the basic operating principle invented by MSFC's Frank Nola for use with single phase generators. Bourbeau advanced the basic technology by refining the controller design to permit its operation with three phase generators. Bourbeau subsequently received—in 1987—a NASA license for the MSFC technology and was



awarded a U.S. patent for his improvements to the Nola invention. The Enerpro device, known as the Auto Synchronous Controller (ASC), is shown below. Enerpro builds all components of the controller in its own facility; at right a company technician is checking a control circuit board and at right below Enerpro engineers are computer testing an ASC.

A primary design objective of the ASC is to reduce generator "inrush" current, a short duration of typically 12 to 15 times rated current that occurs when large generators are brought on line abruptly. The ASC controls the voltage applied to the generator so that the generator is smoothly connected to the utility grid when the generator reaches its synchronous speed. This protects generator components from damage caused by inrush current.

The ASC also increases generator efficiency in light winds. Wind powered generators are sized to produce rated power at wind velocities of about 30 miles per hour; as a result, they are considerably oversized for the more typical wind velocities—10 to 25 miles per hour—usually encountered in wind farm environments, hence they are inefficient when operating in light winds.



The ASC applies lower than rated voltage to the generator in light winds; this in effect converts the oversized generator into an electrically "smaller" machine, reducing internal electrical losses and increasing power output.

The Enerpro ASC won a 1987 award for energy conservation from the California Energy Commission. Enerpro's first sale—in 1985—was to Carter Wind Systems, Burkburnett, Texas and since then the company has delivered some 1,500 units, including installations in The Netherlands, West Germany, the United Kingdom, Sardinia and Kenya. Enerpro recently won a major contract from Cannon Energy Corporation for 36 controllers to be installed on 200 kilowatt wind turbines at a site near Tehachapi, California.

